

August 28, 2015

VIA ELECTRONIC FILING

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*; GN Docket No. 14-177; Written *Ex Parte* Communication

Dear Ms. Dortch:

Samsung Electronics America, Inc. and Samsung Research America (“Samsung”) have been active participants in the above-references proceeding. Samsung appreciates the Federal Communications Commission’s (“Commission”) leadership in encouraging exploration of next generation mobile broadband services (“5G”) and strongly supports Chairman Wheeler’s announced intent to initiate a Notice of Proposed Rulemaking (“NPRM”) in 2015.¹ To support the Chairman’s goal, Samsung provides below its recommendations on technical rules associated with 5G services that the Commission should consider when drafting its 5G Notice of Proposed Rulemaking. In particular, the Commission should continue to focus on developing regulations that will permit licensed mobile broadband systems in the 28 GHz and 39 GHz LMDS bands as well as the 37/42 GHz bands for 5G, with a secondary eye towards other bands such as 60 GHz.

I. SAMSUNG’S RECOMMENDATIONS FOR THE 5G NPRM

The record in the *Spectrum Frontiers NOI* highlights the importance of prompt Commission consideration of spectrum bands for 5G services.² Recently, a number of licensees in millimeter wave band spectrum and equipment vendors have commented on how the 5G NPRM could be drafted to encourage development of next generation mobile broadband services.³ Samsung takes this opportunity to provide its feedback on the best technical approaches raised by these filings as well as to note its preferred approach for the Commission on these matters.

¹ See “Leading towards Next Generation “5G” Mobile Services,” Official FCC Blog at <https://www.fcc.gov/blog/leading-towards-next-generation-5g-mobile-services> (last visited August 24, 2015) (“5G Blog”).

² See *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al.*, Notice of Inquiry, 29 FCC Rcd 13020 (2014) (“*Spectrum Frontiers NOI*”).

³ See e.g., *Ex Parte* Presentation of Straight Path Communications, Inc., GN Docket No. 14-177, filed August 5, 2015 (“*Straight Path Ex Parte*”); *Ex Parte* Presentation of Intel Corporation, GN Docket No. 14-177, filed August 10, 2015 (“*Intel Ex Parte*”); *Ex Parte* Presentation of Nokia (d/b/a Nokia Solutions and Networks US LLC); GN Docket No. 14-177, filed August 13, 2015 (“*Nokia Ex Parte*”); *Ex Parte* Presentation of Alcatel-Lucent, GN Docket No. 14-177, filed May 11, 2015 (“*Alcatel Ex Parte*”); *Ex Parte* Presentation of FiberTower Spectrum Holdings, LLC, GN Docket No. 14-177, filed April 24, 2015 (“*FiberTower Ex Parte*”).

A. Timing of 5G NPRM

Samsung agrees with those in the record that urge quick action on the 5G NPRM.⁴ In particular, Samsung believes it would be extremely beneficial if the Commission could adopt the 5G NPRM prior to the World Radio Conference 2015 (“WRC-15”) that is set to begin in November.⁵ Adoption of an NPRM prior to the WRC will signal internationally that the United States intends to continue to lead the world in the investigation of new spectrum bands for mobile broadband services. WRC-15 will be considering an agenda item for WRC-19 for spectrum bands to consider for 5G. Samsung is encouraged that the United States has supported and helped to approve at the recent CITEL an Inter-American Proposal (“IAP”) that would recommend study of a number of spectrum bands for 5G services⁶, including the bands contained in the *Spectrum Frontiers NOI*.⁷ If the Commission approves a 5G NPRM before WRC-15 deliberations, it will directly signal to other ITU member nations which spectrum bands should be the focus of study item for WRC-19 on 5G services.

B. Recommended Spectrum Bands

For the NPRM, Samsung agrees with those parties that urge the Commission to consider all spectrum bands discussed in the *Spectrum Frontiers NOI* and also suggests adding those bands that were mentioned in the *5G Blog* by Chairman Wheeler. Specifically, Samsung recommends the rulemaking prioritize the::

- LMDS Band (27.5-28.35 GHz, 29.1-29.25 GHz, and 31.0-31.3 GHz)
- 39 GHz Band (38.6-40.0 GHz) and 37/42 GHz Band (37.0-38.6 GHz and 42.0-42.5 GHz)
- 60 GHz Band (57-64 GHz and 64-71 GHz)
- 32 GHz Band (31.8-33.4 GHz)

Samsung recommends adding the 32 GHz band due to the level of interest expressed in the regional preparation process for WRC-15.⁸

C. Licensing and Band Plans

As detailed in its initial comments to the *Spectrum Frontiers NOI*, Samsung supports licensing of the above bands for 5G services.⁹ Absent licensing spectrum on an exclusive basis,

⁴ See e.g., *Intel Ex Parte* “Recommendations on the Use of Spectrum Bands Above 24 GHz for Mobile Radio Services,” at 1; *Straight Path Ex Parte* at 1.

⁵⁵ See Schedule for WRC-15 at <http://www.itu.int/en/ITU-R/conferences/wrc/2015/Pages/default.aspx> (indicating that WRC-15 will start on November 2, 2015 in Geneva, Switzerland).

⁶ See Member States of the Inter-American Telecommunication Commission (CITEL), “Proposals for the Work of the Conference – Agenda Item 10” (IMT Above 6 GHz), XXVI Meeting of PCC.II, Doc. P2!R-4000-10K-6GHz_i, 21 August 2015.

⁷ *Id.* Bands include: 10-10.45 GHz, 23.15-23.6 GHz, 24.25-27.5 GHz, 27.5-29.5 GHz, 31.8-33 GHz, 37-40.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 59.3-76 GHz.

⁸ See 5th Meeting of the APT Conference Preparatory Group for WRC-15 (APG15-5), “Preliminary common proposals on WRC-15 Agenda Item 10”, Document APG15-5/OUT-40 at http://www.apr.int/sites/default/files/2015/08/APG15-5-OUT-40_PACP_AI10.docx. See Also 8th meeting of the Conference Preparatory Group Project Team A, “European Common Proposals for the Work of the Conference”, PTA-TEMP-48, 19 August 2015 at [http://www.cept.org/Documents/cpg-pt-a/26610/CPG-PTA\(15\)145-Annex-V-34r1_-AI10-Draft-ECP](http://www.cept.org/Documents/cpg-pt-a/26610/CPG-PTA(15)145-Annex-V-34r1_-AI10-Draft-ECP).

⁹ See Comments of Samsung Electronics America, Inc. and Samsung Research America, GN Docket No. 14-177, filed January 15, 2015 at 36-37.

with full flexibility granted to licensees to deploy service, 5G services may not be deployed in a robust fashion. Indeed, a purely unlicensed, non-exclusive framework for mobile operations may stunt investment in 5G network deployment because of the uncertainty of parties about prospects for obtaining a return on investment.¹⁰ In general, Samsung reiterates its desire for the Commission to license 5G services through competitive bidding and allow licensees full flexibility to aggregate and disaggregate spectrum to provide the coverage and capacity needed in their particular licensed markets. Additionally, Samsung provides in a table below its specific band plan recommendations for the spectrum bands proposed for 5G services:

Spectrum Band	Recommended Band Plan
LMDS	27.5-28.35 GHz – Single 850 MHz license block 29.1-29.25 GHz – Single 125 MHz license block ¹¹ 31.0-31.3 GHz – Single 300 MHz license block
39 GHz and 37/42 GHz	37-39 GHz – Two 1000 MHz license blocks 39-39.4 GHz – Single 400 MHz license block 39.4-39.8 GHz – Two 200 MHz license blocks 39.8-40 GHz – Four 50 MHz license blocks ¹² 42-42.5 GHz – Single 500 MHz license block
64-71 GHz	64-68 GHz – Two 2000 MHz license blocks 68-71 GHz Licensed – Three 1000 MHz license blocks

The above proposal reflects Samsung’s view that the bandwidth for a single carrier component is 200 MHz. To achieve the desired target data rates for 5G services, at least four contiguous carrier components should be available to a single licensee.¹³

D. Technical Rules and Link Budget

To help the Commission develop technical rule proposals for 5G services, Samsung has created a representative link budget for a variety of the spectrum bands under consideration. This detailed link budget is attached as an Appendix to this filing.

EIRP Requirements. Samsung suggests, based on the link budgets provided, that the Commission regulate transmit power based on EIRP – allowing licensees and equipment vendors some flexibility in meeting these requirements. Specifically, Samsung believes that the EIRP values for 5G should be based on a dBm per MHz metric and provides recommendations in the table below.

¹⁰ *Id.* at 37.

¹¹ Samsung recommends that in the NPRM the Commission consider this band in a further rulemaking beyond the initial NPRM. In this further NPRM, the Commission should seek input regarding sharing with current incumbent satellite users.

¹² This is primarily to accommodate current LMDS licensees which cannot be aggregated into a larger spectrum block. If these blocks are not needed to accommodate LMDS licensees then the Commission should consider aggregating these blocks to a 200 MHz channel.

¹³ An analogy would be in the current CMRS bands the building block for licensees are 5 MHz, with the component carriers are 1.4 MHz, 3 MHz, and 5 MHz.

Band	Base Station EIRP (dBm/MHz)	Mobile Station EIRP (dBm/MHz)
LMDS	36	14
39 GHz and 37/42 GHz	37	15
64-71 GHz	37	12

OBE Limits. For out of band emission (“OOBE”) limits, Samsung would suggest that the Commission maintain the current limits that have been adopted for millimeter wave spectrum bands. Sections 101.111(a)(2)(ii), (iii), (iv) and (v) of the Commission’s rules contains the OBE limits that should be proposed for any 5G spectrum bands.¹⁴

II. CONCLUSION

Samsung is tremendously excited about the potential for 5G and commends the Commission for taking expeditious action to develop a Notice of Proposed Rulemaking. Samsung recommends that the Commission adopt a 5G NPRM prior to the WRC-15 and continue to support efforts on the agenda item for WRC-19 that will enable 5G throughout the world. In the attachment to this filing, Samsung presents its technical recommendations for operations above 24 GHz based upon its extensive testing efforts in these spectrum bands. Samsung looks forward to continuing to work cooperatively with the Commission to unleash spectrum above 24 GHz to create unparalleled mobile experiences for the American public, and the rest of the world.

Respectfully submitted,

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¹⁴ See 47 C.F.R. §§101.111(a)(2)(ii), (iii), (iv) and (v).

Appendix: Representative Link Budget

Item	28 GHz Downlink	28 GHz Downlink	28 GHz Uplink	39 GHz Downlink	39 GHz Uplink	67 GHz Downlink	67 GHz Uplink	See Note
Deployment scenario	UMi	UMi	UMi	UMi	UMi	UMi	UMi	Note 1
System configuration								
Carrier frequency [GHz]	28	28	28	39	39	67	67	
Path loss model	(A)	(B)	(A)	(C)	(C)	(D)	(D)	Note 2
Transmitter								
(1) Number of transmit antennas (antenna means subarray)	32	32	8	64	16	64	16	
(2) Maximal transmit power per antenna [dBm]	27.0	27.0	12.0	22.0	7.0	19.0	4.0	
(3) Total transmit power = function of (1) & (2) [dBm]	42.1	42.1	21.0	40.1	19.0	37.1	16.0	
(4) Transmitter antenna gain per antenna [dBi]	11	11	5	11	5	14	5	
(5) Transmitter array gain a.k.a beamforming gain [dB]	15.1	15.1	9.0	18.1	12.0	18.1	12.0	
(6) Cable, connector, combiner, body losses, etc. [dB]	3	3	4	3	4	3	4	
(7) Required EIRP [dBm] (to close link budget)	65	65	31	66	32	66	29	Note 3
Receiver								
(8) Number of receive antennas (antenna means subarray)	8	8	32	16	64	16	64	
(9) Receiver antenna gain per antenna [dBi] (4)	5	5	11	5	11	5	14	
(9-a) Receiver array gain a.k.a beamforming gain [dB] (5)	9.0	9.0	15.1	12.0	18.1	12.0	18.1	
(10) Cable, connector, combiner, body losses, etc. [dB]	4	4	3	4	3	4	3.0	
(11) Receiver noise figure [dB]	9	9	5	9	5	9	5	Note 4
(12) Thermal noise density [dBm/Hz]	-174	-174	-174	-174	-174	-174	-174	
(13) Receiver interference density [dBm/Hz]	-165	-165	-170	-165	-170	-165	-170	Note 5
(14) Total noise plus interference density [dBm/Hz]	-162	-162	-166	-162	-166	-162	-166	
(15) Occupied channel bandwidth [MHz]	900	900	56.25	900	56.25	900	56.25	Note 6
(16) Effective noise power = (14) + 10log((15)) + 60 [dBm]	-72	-72	-89	-72	-89	-72	-89	
(17) Required SNR [dB]	-5.00	-5.00	-10.00	-5.00	-10.00	-5.00	-10.00	Note 7
(19) Receiver implementation margin [dB]	2	2	2	2	2	2	2	
(20) Receiver sensitivity = (16) + (17) + (18) [dBm]	-75	-75	-97	-75	-97	-75	-97	
(21) Hardware link budget = (7) + (9) + (9-a) - (20) [dB]	154	154	154	158	158	158	158	
Calculation of available path loss								
(22) Lognormal shadow fading std deviation [dB]	8	18	8	8	8	8	8	Note 8
(23) Shadow fading margin (function of the cell area reliability and (22)) [dB]	10.4	23.4	10.4	10.4	10.4	10.4	10.4	Note 9
(24) Available path loss = (21) - (23) - (10) [dB]	140	127	141	144	145	144	145	

Item	28 GHz Downlink	28 GHz Downlink	28 GHz Uplink	39 GHz Downlink	39 GHz Uplink	67 GHz Downlink	67 GHz Uplink	See Note
Range/Coverage efficiency calculation								
(25) Maximum range (based on (24) and according to the system configuration section of the link budget) [m]	149.0	147.1	154.0	151.5	156.6	103.3	106.8	
<p>Note 1: UMi is a deployment scenario in the Urban Micro environment</p> <p>Note 2: For all cases except (B), ITU-R M.2135 UMi Hexagonal Path loss model ($PL=36.7\log_{10}(d)+22.7+26\log_{10}(fc)$) is used, this model is originally defined limited to 6 GHz. We changed the center frequency (fc) according to the corresponding case and it gives the following path loss equation :</p> <p>Case (A) $PL = 36.7 \log_{10}(d) + 60.3$ (NLOS)</p> <p>Case (B) $PL = 30.3 \log_{10}(d) + 61.4$ (NLOS)</p> <p>Case (C) $PL = 36.7 \log_{10}(d) + 64.1$ (NLOS)</p> <p>Case (D) $PL = 36.7 \log_{10}(d) + 70.2$ (NLOS)</p> <p>Please note that we found the similarity at 28 GHz between M.2135 path loss model with our own developed path loss model.</p> <p>Note 3: Required EIRP to support cell radius 150m (ISD≈300m) for 28/39 GHz and 100m (ISD≈200m) for 67 GHz</p> <p>Note 4: Typical values : 7 dB at Mobile device, 5 dB at BS</p> <p>Note 5: Assuming light interferences at 2 dB Interference over thermal ratio</p> <p>Note 6: Maximum 1 GHz system bandwidth considering guard bands, Occupied system bandwidth of 900 MHz. In uplink case, occupied bandwidth is assumed as 16 times smaller than total occupied bandwidth for downlink.</p> <p>Note 7: Assuming required SNR of -5/-10 dB for DL/UL cell-edge users</p> <p>Note 8: Industry still developing consensus on lognormal shadow fading distribution, 8 dB might be an optimistic value.</p> <p>Note 9: 1.3 x (row 22) for 90% cell-edge coverage reliability (tight margin)</p>								

¹⁵ Technical Paper Pending Publication.